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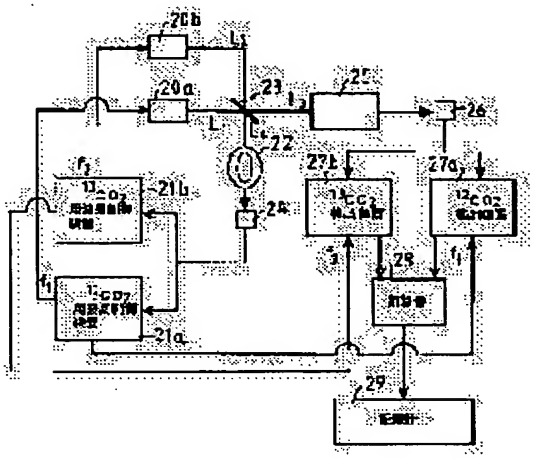
(71)Applicant : TOKYO GAS CO LTD
(72)Inventor : TAI HIDEO

(54) GAS MEASURING INSTRUMENT

(57)Abstract:
PURPOSE: To enable a gas measuring instrument which measures the ratio of concentration between two kinds of gases by using a semiconductor laser to accurately measure the ratio of concentration in a short time with a simple constitution without using any cooling mechanism.
CONSTITUTION: After two laser beams modulated with different frequencies are mixed with each other through a beam splitter 23 and passed through a reference cell 22 in which 12CO2 and 13CO2 which is the isotope of 12CO2 are enclosed, the mixed laser beam are received by means of a photodetector 24 and the oscillating wavelengths of the laser beams corresponding to the absorption wavelength of the reference gases are respectively stabilized in a wavelength controllers 21a for 12CO2 and 21b for 13CO2. Then, after the mixed laser beams are transmitted through a gas containing the two kinds of gases to be measured for the ratio of concentration in a cell 25 for measurement, the laser beams are received by means of a photometer 26 and the concentrations of the 12CO2 and 13CO2 are respectively detected by means of a 12CO2 detector 27a and CO detector 27b. Thereafter a divider find the ratio of concentration between by dividing the concentration of 13CO2 by the sum of the concentrations of 12CO2 and 13CO2.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The semiconductor laser which is two from which oscillation wavelength and modulation frequency differ, and a mixed means to mix the laser beam by which outgoing radiation is carried out from this semiconductor laser, The cel for measurement which holds temporarily the gas containing two kinds of gas which should measure the ratio of concentration, The cel for reference with which the gas of the same class as said two kinds of gas was enclosed, and the 1st light-receiving means which receives the laser beam which was mixed by said mixed means and penetrated this cel for reference, this — a frequency component equal to said modulation frequency being detected from the output of the 1st light-receiving means, and with a wavelength stabilization means to stabilize the wavelength of each of said semiconductor laser based on this frequency component, respectively The 2nd light-receiving means which receives the laser beam which penetrated the cel for the account measurement of back to front mixed by said mixed means, this — two detection equipments which detect the concentration of two kinds of said gas from the output of the 2nd light-receiving means — this — one value of the output of two detection equipments — this — the gas determination equipment characterized by having the divider which computes the ratio of concentration by carrying out division process by the sum of the value of the output of two detection equipments.
[Claim 2] two kinds of gas which is going to measure the ratio of concentration — carbon-dioxide 12CO2 and carbon-dioxide 13CO2 it is — the oscillation wavelength of said two semiconductor laser — carbon-dioxide 12CO2 Absorption wavelength and carbon-dioxide 13CO2 Gas determination equipment according to claim 1 characterized by being equal to absorption wavelength respectively.
[Claim 3] Gas determination equipment according to claim 1 characterized by said mixed means being a beam splitter.
[Claim 4] Gas determination equipment according to claim 1 characterized by said mixed means being a fiber coupler.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the gas determination equipment which measures the ratio of concentration of two kinds of gas using a semiconductor laser component.
[0002]
[Description of the Prior Art] Stress and bacteria are known by the main things of the cause of gastritis. Since administration of an antibiotic is effective when bacteria are the cause therefore, it is necessary to check whether bacteria exist in a patient. This kind of bacteria are urea 12CO (NH2)2 of a certain kind. It decomposes and is carbon-dioxide 12CO2. Urea 13CO2 which contains in a patient carbon 13 C which is the isotope of carbon 12 C as a marker since there is a property to discharge (NH2) Carbon-dioxide 13CO2 in the exhalation which prescribes a medicine for the patient and is discharged by the patient What is necessary is just to detect.
[0003] Carbon-dioxide 13CO2 from which the ratio of concentration (value which carried out division process of the concentration of carbon-dioxide 13CO2 by the sum of the concentration of carbon-dioxide 13CO2 and the concentration of carbon-dioxide 12CO2) is set to about 0.011 into atmospheric air on the other hand Since it is contained In the exhalation discharged by the patient when bacteria do not exist in a gastritis patient's inside of the body, it is carbon-dioxide 13CO2 in this atmospheric air. Although that ratio of concentration is about 0.01 since it is only contained Carbon-dioxide 13CO2 contained in atmospheric air in exhalation when bacteria exist in a patient's inside of the body Since carbon-dioxide 13CO2 which bacteria discharge in addition is contained, the ratio of concentration increases to about 0.015-0.02 from about 0.011. So, in order to detect the existence of bacteria, it is carbon-dioxide 13CO2. It is carbon-dioxide 13CO2 about concentration. Concentration and carbon-dioxide 12CO2 What is necessary is to carry out division process and just to ask by the sum with concentration.
[0004] The infrared spectrometer is known as equipment which measures the ratio of concentration of two kinds of conventionally different gas, and drawing 2 is the outline block diagram of the example.
[0005] drawing — setting — an infrared spectrometer 1 — carbon-dioxide 12CO2 13COs2 which detect the carbon-dioxide 13CO2 An analyzer 2, the data processor 3 which performs data processing, and carbon-dioxide 12CO2 to time amount Concentration change and carbon-dioxide 13CO2 It consists of 2 pen recorders 4 which record concentration change on coincidence as a graph.
[0006] 13COs2 The light source 5 to which an analyzer 2 carries out outgoing radiation of the infrared radiation, and the reflecting mirror 6 which reflects the infrared radiation from the light source 5, The sample cell 7 which takes in a patient's exhalation from Inlet A and is exhausted from an exhaust port B, The sector mirror 9 which performs by turns reflection and passage of the light which carried out incidence to the reference cell 8 which encloses the gas for carrying out comparison contrast, It consists of the monochromator 10, a PbSe (lead selenide) detector 11, an automatic-gain-control device 14 that consists of amplifier 12 and a sample hold circuit 13, and a logarithmic transformation machine 15. The monochromator 10 consists of the slit 16, a collimator mirror 17, a diffraction grating 18, and a chopper 19, and carries out the spectrum of the one beam of light to two.
[0007] It is carried out with a reflecting mirror 6 for 2 minutes, passes along a sample cell 7 and a reference cell 8, and goes into a monochromator 10 by turns in the sector mirror 9, and the light which came out of the light source 5 is 12CO2 and 13CO2. A spectrum is carried out to absorption wavelength and incidence is carried out to a detector 11. Automatic gain control of the detection signal outputted from a detector 11 is carried out by the automatic-gain-control device 12, and it is inputted into the logarithmic transformation machine 13 so that the luminous intensity which passes a reference cell 8 may become fixed. The output of the logarithmic transformation machine 15 is amended by the data processor 3, and is printed on the 2 pen recorders 4.
[0008]
[Problem(s) to be Solved by the Invention] However, in such an infrared spectrometer, since temperature dependence is in the sensibility of a detector 11 and it must cool to -72-degreeC using the cooler style which uses dry ice-ethyl alcohol as a refrigerant, when equipment becomes complicated, it will enlarge. Moreover, the concentration of two kinds of gas is separately recorded on the recording paper of the 2 pen recorders 4, and when an operator looks at and judges it, since the ratio of concentration is unclear, there is a trouble of taking time amount.
[0009] This invention is made in view of the above-mentioned point, and the purpose is in offering the measuring device which measures correctly the ratio of concentration of two kinds of gas with a brief configuration for a short time, without using a cooler style in the equipment which detects the ratio of concentration of two kinds of gas

using semiconductor laser.
[0010]
[Means for Solving the Problem] The semiconductor laser said whose purpose is two from which oscillation wavelength and modulation frequency differ according to this invention, A mixed means to mix the laser beam by which outgoing radiation is carried out from semiconductor laser, and the cel for measurement which holds temporarily the gas containing two kinds of gas which should measure the ratio of concentration, The cel for reference with which the gas of the same class as two kinds of gas was enclosed, and the 1st light-receiving means which receives the laser beam which was mixed by the mixed means and penetrated the cel for reference, A wavelength stabilization means to detect a frequency component equal to modulation frequency from the output of the 1st light-receiving means, and to stabilize the wavelength of each semiconductor laser based on a frequency component, respectively, The 2nd light-receiving means which receives the laser beam which penetrated the cel for post-measurement mixed by the mixed means, It is attained by gas determination equipment equipped with the divider which computes the ratio of concentration by carrying out division process of one value of the output of two detection equipments which detect the concentration of two kinds of gas from the output of the 2nd light-receiving means, and two detection equipments by the sum of the value of the output of two detection equipments.
[0011]
[Function] According to this invention, the laser beam which carries out outgoing radiation from the semiconductor laser which is two from which oscillation wavelength and modulation frequency differ is mixed. The laser beam which penetrated the cel for reference with which the gas of the same class as two kinds of gas which should measure the ratio of concentration was enclosed is received with the 1st light-receiving means. A frequency component equal to said modulation frequency is detected from the output of the 1st light-receiving means. Based on a modulation frequency component, the wavelength of each semiconductor laser is stabilized, respectively. The laser beam which penetrated the cel for measurement in which the gas containing two kinds of gas which should measure the back ratio of concentration mixed by the mixed means was held temporarily is received with the 2nd light-receiving means. Two detection equipments detect the concentration of two kinds of gas from the output of the 2nd light-receiving means, and the ratio of concentration is computed by carrying out division process of one value of the output of two detection equipments by the sum of the value of the output of two detection equipments.
[0012]
[Example] This invention is explained based on a drawing below.
[0013] Drawing 1 is the outline block diagram of one example of the gas determination equipment by this invention, and is carbon-dioxide 12CO2 from a gastritis patient's exhalation here. What was applied to the equipment which measures the ratio of concentration with carbon-dioxide 13CO2 which is the isotope, and judges the existence of bacteria from the change is illustrated.
[0014] The illustrated gas determination equipment Two semiconductor laser components 20a and 20b, While stabilizing the oscillation wavelength of semiconductor laser component 20a, it is a frequency f1. 12COs2 to modulate ** wavelength control unit 21a, While stabilizing the oscillation wavelength of semiconductor laser component 20b, it is a frequency f2. 13COs2 to modulate ** wavelength control unit 21b, Carbon-dioxide 12CO2 Carbon-dioxide 13CO2 which is this isotope The cel 22 for reference with which mixed gas was enclosed, The beam splitter 23 which mixes the modulated laser beam by which outgoing radiation is carried out from each semiconductor laser components 20a and 20b, The photodetector 24 as 1st light-receiving means which receives the laser beam which was outputted from the beam splitter 23 and penetrated the cel 22 for reference, and is changed into an electrical signal, Urea 13CO2 containing carbon 13 C which is the isotope of carbon 12 C (NH2) The cel 25 for measurement in which the exhalation (carbon-dioxide 13CO2 of strange concentration is included) of the patient who prescribed a medicine for the patient is held temporarily, The photodetector 26 as 2nd light-receiving means which receives the laser beam which is outputted from a beam splitter 23 and passes the cel 25 for measurement, and is changed into an electrical signal, The electrical signal and 12COs2 which are outputted from a photodetector 26 Frequency f1 outputted from ** control unit [wavelength] 21a A signal to 12COs2 12COs2 which detect concentration Detection equipment 27a, The electrical signal outputted from a photodetector 26, and frequency f2 outputted from wavelength control unit 21for 13COs2 b A signal to carbon-dioxide 13CO2 13COs2 which detect concentration Detection equipment 27b, 13COs2 They are 13COs2 about the output (concentration) of detection equipment 27b. The output (concentration) and 12COs2 of detection equipment 27b It consists of a divider 28 which carries out division process by the sum with the output (concentration) of detection equipment 27a, and a recorder 29 which records the value of a divider 28.
[0015] The semiconductor laser components 20a and 20b have the property that oscillation wavelength becomes short, if oscillation wavelength will become long if the temperature of the component itself becomes high, and temperature becomes low, and the Peltier device which is not illustrated is attached in the semiconductor laser components 20a and 20b through the heat-conduction plate.
[0016] The P-type semiconductor and the N-type semiconductor are connected and constituted through the metal plate by turns, and since a connection is heated or cooled by the direction where a current flows, a Peltier device can stabilize the oscillation wavelength of the semiconductor laser components 20a and 20b by controlling the electrical potential difference or current impressed to a Peltier device.
[0017] Generally the beam splitter 23 consists of half mirrors, and divides into two, the reflected light and the transmitted light, the light beam by which incidence was carried out to the half mirror at an angle of predetermined. In addition, a fiber coupler may be used instead of a beam splitter 23. Outgoing radiation is carried out from

semiconductor laser component 20a, and it is an optical path L1. While the part penetrates a beam splitter 23 and carries out incidence of the laser beam along which it passes to the cel 25 for measurement, other parts reflect by the beam splitter 23, and carry out incidence of it to the cel 22 for reference. Outgoing radiation is carried out from semiconductor laser component 20b, and it is an optical path L2. While the part reflects by the beam splitter 23 and carries out incidence also of the laser beam along which it passes to the cel 25 for measurement similarly, other parts penetrate a beam splitter 23 and carry out incidence of it to the cel 22 for reference.

[0018] The semiconductor laser components 20a and 20b, the cel 22 for reference, and the cel 25 for measurement optical path L3 of the laser beam which outgoing radiation was carried out from semiconductor laser component 20a, and penetrated the beam splitter 23 optical path L3 of a laser beam which carried out outgoing radiation from semiconductor laser component 20b and which was reflected by the beam splitter 23 Optical path L4 of the laser beam which has been arranged so that it may be in agreement, and outgoing radiation was carried out from semiconductor laser component 20b, and penetrated the beam splitter 23 Optical path L4 of a laser beam which outgoing radiation was carried out from semiconductor laser 20a, and was reflected by the beam splitter 23 It is arranged so that it may be in agreement. For this reason, an optical path L3 and L4 In a top, since the laser beam which carried out outgoing radiation from semiconductor laser component 20a, and the laser beam which carried out outgoing radiation from semiconductor laser component 20b will be mixed, a beam splitter 23 functions as a mixed means.

[0019] Although photodetectors 24 and 26 are components which change into an electrical signal the laser beam which carried out incidence, for example, a photodiode is used, it is not limited to this but a photo transistor may be used.

[0020] 12COs2 ** wavelength control unit 21a is a frequency f1 about the drive current of semiconductor laser component 21a while performing a temperature control so that the temperature of the Peltier device attached in semiconductor laser component 20a may turn into predetermined temperature in order to carry out the monitor of the wavelength of semiconductor laser component 20a from the output component from a photodetector 24 and to stabilize oscillation wavelength. It becomes irregular. 13COs2 Similarly, ** wavelength control-device 21b is a frequency f2 about the drive current of semiconductor laser component 20b, while performing the temperature control of semiconductor laser component 20b so that the temperature of the Peltier device by which it was attached in semiconductor laser component 20b may turn into predetermined temperature. It becomes irregular.

[0021] 12COs2 The phase-sensitive detection machine with which detection equipment 27a outputs a fundamental-wave phase-sensitive detection signal (it is proportional to the reinforcement of the laser beam which penetrated the cel 25 for measurement), The phase-sensitive detection machine which outputs 2 double wave phase-sensitive detection signal (it is proportional to the concentration of carbon-dioxide 12CO2 contained in the reinforcement and the cel 25 for measurement of a laser beam which penetrated the cel 25 for measurement), It is carbon-dioxide 12CO2 by having the divider and carrying out division process of the value of 2 double wave phase-sensitive detection signal with the value of a fundamental-wave phase-sensitive detection signal. Concentration is outputted.

[0022] 13COs2 Detection equipment 27b is 12CO2. The phase-sensitive detection machine which outputs a fundamental-wave phase-sensitive detection signal like detection equipment 27a, It is carbon-dioxide 13CO2 by having the phase-sensitive detection machine which outputs 2 double wave phase-sensitive detection signal, and the divider, and carrying out division process of the value of 2 double wave phase-sensitive detection signal with the value of a fundamental-wave phase-sensitive detection signal. Concentration is outputted.

[0023] A divider 28 is 13CO2. The value of the output (concentration of carbon-dioxide 13CO2) of detection equipment 27b, 12COs2 Computing the ratio of concentration (value which carried out division process of the concentration of above-mentioned carbon-dioxide 13CO2 by the sum of the concentration of carbon-dioxide 13CO2, and the concentration of carbon-dioxide 12CO2) from the value of detection equipment 27a (concentration of carbon-dioxide 12CO2), a recorder 29 records the result of a divider 28.

[0024] In addition, the modulation frequency f1 of the semiconductor laser components 20a and 20b and f2 Since it is known that the accuracy of measurement of the one where the least common multiple is larger will improve, it is carbon-dioxide 12CO2, for example. Modulation frequency f1 of semiconductor laser component 20a of ** 51kHz Carbon-dioxide 13CO2 Modulation frequency f2 of semiconductor laser component 20b of ** 49kHz It chose. As long as modulation frequency is not an integral multiple mutually, it may also choose other frequencies.

[0025] Next, actuation of the gas determination equipment of the above-mentioned configuration and the judgment of the existence of bacteria are explained.

[0026] They are 12COs2 first. ** wavelength control unit 21a and 13COs2 ** wavelength control unit 21b is driven. Semiconductor laser component 20a is carbon-dioxide 12CO2. While exciting on wavelength equal to absorption wavelength, it is the frequency of 51kHz. Becoming irregular, semiconductor laser component 20b is carbon-dioxide 13CO2. While exciting on wavelength equal to absorption wavelength, it is the frequency of 49kHz. It becomes irregular. Consequently, from each semiconductor laser components 20a and 20b, the laser beam modulated on the predetermined frequency focusing on the predetermined bias current is oscillated.

[0027] In this way, a mixed light of the laser beam which outgoing radiation was carried out from semiconductor laser component 20a between two oscillated laser beams, and penetrated the beam splitter 23, and the laser beam which outgoing radiation was carried out from semiconductor laser component 20b, and was reflected by the beam splitter 23 is changed into an electrical signal with the glory detector 24 which passed the cel 22 for reference. The output signal acquired from a photodetector 24 is 12CO2, respectively, although inputted into the wavelength control units 21a and 21b. It sets to ** wavelength control unit 21a, and is the frequency of 51kHz. Since signal

processing is performed only about a modulated wave, the electrical potential difference of a Peltier device is controlled and the temperature of semiconductor laser component 20a is controlled, it is carbon-dioxide 12CO2. Oscillation wavelength is stabilized by absorption wavelength. On the other hand, 13COs2 It sets to ** control unit 21b, and is the frequency of 49kHz. Signal processing is performed only about a modulated wave, the electrical potential difference of a Peltier device is controlled, and the temperature of semiconductor laser component 20b is controlled. the output signal which the wavelength control devices 21a and 21b consist of a phase-sensitive detection machine, an integrator, a power supply for the Peltier element, etc., and was acquired from the photodetector 24 — respectively — the modulation frequency of 49kHz, and 51kHz about — the phase-sensitive detection signal of a fundamental wave is searched for, and the temperature of the semiconductor laser components 20a and 20b is controlled so that the value serves as zero. Thereby, the oscillation wavelength of the semiconductor laser components 20a and 20b is carbon-dioxide 12CO2 and carbon-dioxide 13CO2, respectively. The core of the absorption line is stable at coincidence.

[0028] It is changed into an electrical signal with the glory detector 26 which penetrated the cel 25 for measurement, and a mixed light of the laser beam which outgoing radiation was carried out from semiconductor laser component 20a, and penetrated the beam splitter 23 on the other hand, and the laser beam which outgoing radiation was carried out from semiconductor laser component 20b, and was reflected by the beam splitter 23 is 12CO2. Detection equipment 27a and 13COs2 It is inputted into ** detection equipment 27b. 12COs2 Detection equipment 27a is carbon-dioxide 12CO2. The signal corresponding to concentration is outputted and it is 13CO2. Detection equipment 27b Carbon-dioxide 13CO2 Outputting the signal corresponding to concentration, a divider 28 is carbon-dioxide 13CO2. The value and carbon-dioxide 12CO2 of a signal corresponding to concentration Calculating the ratio of concentration from the value of the signal corresponding to concentration, a recorder 29 records this ratio of concentration.

[0029] When the bacteria which cause gastritis to a patient's inside of the body by this do not exist in the exhalation in the cel 25 for measurement, the ratio of concentration does not change with about 0.011, but since the ratio of concentration increases to about 0.015-0.02 when bacteria exist in the exhalation in the cel 25 for measurement, the existence of bacteria is judged.

[0030] Thus, according to this example, it is a frequency f1. The laser beam of modulated semiconductor laser component 20a, A frequency f2 which is different in frequency f 1 The laser beam of modulated semiconductor laser component 20b is mixed by the beam splitter 23. Light is received with the glory detector 24 which made the gas in the cel 22 for reference with which the gas of the same class as two kinds of gas which should measure the ratio of concentration was enclosed penetrate. 12COs2 It is a frequency f1 at ** wavelength control unit 21a. The oscillation wavelength of the corresponding laser beam is stabilized and it is 13CO2. While stabilizing the oscillation wavelength of the laser beam corresponding to a frequency f2 by ** wavelength control unit 21b Light is received with the glory detector 26 which made the gas in the cel 25 for measurement which holds temporarily the gas containing two kinds of gas which should measure the ratio of concentration penetrate. 12COs2 It is carbon-dioxide 12CO2 at detection equipment 27a. Concentration is detected. 13COs2 It is carbon-dioxide 13CO2 at detection equipment 27b. Concentration is detected. They are 13COs2 by the divider 28. They are 13COs2 about the output value of detection equipment 27b. The output value and 12COs2 of detection equipment 27b By carrying out division process by the sum with the output value of detection equipment 27a, and asking for the ratio of concentration There is no troublesomeness which compares the graph of the 2 pen recorders 4 like the conventional infrared spectrometer, and asks for the ratio of concentration, and the ratio of concentration of two kinds of gas can be correctly measured with a brief configuration, without preparing a cooler style.

[0031] It is carbon-dioxide 12CO2 as two kinds of gas which asks for the ratio of concentration in this example. Carbon-dioxide 13CO2 which is the isotope Although illustrated, it is not limited to this but, of course, measurement of the ratio of concentration can be similarly performed about other gas.

[0032]

[Effect of the Invention] As explained above, in this invention, the laser beam which carries out outgoing radiation from the semiconductor laser which is two from which oscillation wavelength and modulation frequency differ is mixed. The laser beam which penetrated the cel for reference with which the gas of the same class as two kinds of gas which should measure the ratio of concentration was enclosed is received with the 1st light-receiving means. A frequency component equal to said modulation frequency is detected from the output of the 1st light-receiving means. Based on a modulation frequency component, the wavelength of each semiconductor laser is stabilized, respectively. The laser beam which penetrated the cel for measurement in which the gas containing two kinds of gas which should measure the back ratio of concentration mixed by the mixed means was held temporarily is received with the 2nd light-receiving means. Since the ratio of concentration is computable by two detection equipments' detecting the concentration of two kinds of gas from the output of the 2nd light-receiving means, and carrying out division process of one value of the output of two detection equipments by the sum of the value of the output of two detection equipments There is no troublesomeness which compares the graph of 2 pen recorders like the conventional infrared spectrometer, and asks for the ratio of concentration, and the ratio of concentration of two kinds of gas can be correctly measured with a brief configuration, without using a cooler style.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram of one example of the gas determination equipment by this invention.
[Drawing 2] It is the outline block diagram of the conventional infrared spectrograph.
[Description of Notations]
20a, 20b Semiconductor laser component
21a 12CO2 ** wavelength control unit
21b 13CO2 ** wavelength control unit
22 Cel for Reference
23 Beam Splitter
24 26 Photodetector
25 Cel for Measurement
27a 12CO2 Detection equipment
27b 13CO2 Detection equipment
28 Divider
29 Recorder

[Translation done.]